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CONTENTS

Relation between the international and mecanical watts.
Radio echo signal research.
Tests of airplane antennas.
Airplane direction finders.
The spectra of lutecium.
Separation and determination of osmium and ruthenium.
Aberrations of astronomical objectives.
Filters for changing the color temperature of incandescent sources to mean sunlight.
Roof exposure tests of outside white paints.
Enamel versus enamel and varnish for automobile license tags.
Cast iron for enameling purposes.
Change in volume of burned clay bodies during use.
Study of fire clays.
Cement reference laboratory.
Cooperative tests of coatings for pipe lines.
Examination of pipe specimens.
Chart for determining the helix angles of screw threads.
Testing equipment for large-capacity scales.
Examination of old newspapers.
Standards Yearbook, 1930.
Construction activity during January, 1930.
New and revised publications issued during March, 1930.
Recent articles appearing in outside publications.

RELATION BETWEEN THE INTERNATIONAL AND MECHANICAL WATTS

In many precise heat measurements now being made the international joule is used as the energy unit. As outlined in Technical News Bulletin No. 152 (December, 1929), replacement of the present international units by absolute units is in prospect, and this change may become effective within a few years. For many purposes data expressed in mechanical joules are more useful than those expressed in the arbitrary international unit, and the prospective abandonment of the present international electrical units adds to the advantages of expressing results in absolute or mechanical joules.

To reduce results obtained in international joules to their equivalent values in mechanical joules, a conversion factor is needed. In Bureau of Standards Circular No. 60, second edition issued in 1920, it is stated that one international watt=1.00034 mechanical watts.

The ratio published in 1920 is subject to revision in the light of later evidence. The provisional value for the conversion factor given in this note is intended to serve until a more authoritative figure becomes available.

It is desirable in the first place to make it clear that the "international units" as maintained at the different national laboratories are not exactly the same, and precise conversion factors for changing from the "international" to absolute units will, therefore, be slightly different in different countries. The existing differences in the values of the international ohm and volt are, however, only a few parts in 100,000, so that differences of perhaps 1 in 10,000 may exist in the international watt derived from standards maintained by the various national laboratories. A difference of this magnitude is not, however, of major importance in heat measurements.

The International Committee on Weights and Measures at its meeting of June, 1929, definitely accepted the principle of using absolute electrical units. It made no attempt, however, to fix the ratios between those units and the international ones as at present maintained. This problem and the procedure to be followed in making the transition are referred to the Advisory Committee on Electricity for recommendations.

New determinations of the absolute units are in progress at several laboratories. Presumably, the procedure which will be followed in introducing the new units will consist essentially of four steps. First, the results of the new determinations as represented by physical standards (resistance coils and standard cells) will be compared among the several laboratories, and agreement will be reached on a best absolute value for certain groups of standards. Second,

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through comparisons with some of these groups each national laboratory will determine precisely what the conversion factors should be to change over from its present units to the new ones. Third, these conversion factors will be announced, and for a certain period the national laboratories will give values on both bases in certifying standards. Finally, all values will be given only in the new absolute units.

Incidentally, it may be remarked that systematic methods will be adopted to prevent future divergences between countries. If any further adjustment of units should become necessary, it will be made only by international action and should be the same in all countries.

It will require some time before the above procedure can be carried through, since it involves completion of several experimental determinations and adjustment of possible discrepancies in the results. Up to the present time progress in the negotiations has been surprisingly rapid. Some members of the International Advisory Committee have thought that the change in units might be made in two years. It appears not impossible that the necessary agreements on values may be completed in time for formal ratification at the General Conference on Weights and Measures which convenes in 1933, so that the new units would be introduced into general use during the following year.

To fix the values of the units to the sixth figure will be difficult, but experimental data already available are sufficient to justify a prediction to the fifth. There are several lines of evidence indicating that the standards as established in 1910 have not drifted in value by many parts in 100,000, so that all good absolute measurements made since then are still significant.

For the ohm there are three determinations, all indicating that the international ohm is too large by 5 parts in 10,000. For the standard cell absolute values are somewhat less certain. Current balance measurements at the National Bureau of Standards reported in 1913 would give 1.01872 volts, and those made at the British National Physical Laboratory at about that time would indicate about 1.01868, but recent unpublished measurements at the bureau give about 1.01877. Assuming that this more nearly represents the "present American" units, and taking 1.01875 volts as an approximation to the exact value, one may say that probably our volt is too large by about 45 parts in 100,000; that is, the cell is assigned a value of 1.01830 when it should be 1.01875.

In the actual measurement of the joule or the watt the value of the volt enters as the square, since the relation

$$P=\frac{E^2}{R}$$

is used. Consequently, the international joule is too large by about 4 parts in 10,000. The estimate of 4 may be slightly large; in fact, the earlier determinations give a value somewhat nearer 3 in 10,000, but it would be surprising if final values went outside of this range.

Accordingly, it is recommended, upon the basis of data available to the National Bureau of Standards, that in conversions involving international watts and mechanical watts the relation used be:

1 international watt=1.0004 mechanical watts

From data now available it is to be expected that the figure given will not differ from any which may be officially adopted later by more than 1 in 10,000.

RADIO ECHO SIGNAL RESEARCH

A major purpose in the study of radio-wave phenomena carried on by the bureau is to understand more completely what happens to the radio waves between the transmitting and the receiving stations. It is well known that part of the radiation from the transmitting station reaches the upper atmosphere, from which it may be refracted back to earth. It is this refraction that makes possible long-distance communication.

In order to determine some of the properties of the upper atmosphere which are responsible for this phenomenon, the bureau and a number of other laboratories are cooperating in a study of echo signals. The procedure in this study is to record, by means of an oscillograph, the received signals from a powerful transmitter which is sending out pulses of extremely short duration. The oscillograph record shows for each pulse sent out, a sharp peak for the wave coming along the surface of the earth, followed at a measurable time later by one or more peaks representing "echoes" from the upper atmosphere. By measuring on the oscillogram the interval of time between the reception of the ground wave and the sky wave it is possible by simple calculation to determine the apparent height in the atmosphere which the wave reached. In this method of calculation it is assumed that reflection takes place from an ionized layer in the upper atmosphere. Actual reflection, as from a mirror, does not take place, but a gradual bending or refraction occurs,

due to an increase of ionization with height, so that the actual height reached by the wave is somewhat less than that given by the calculation.

At present, pulse signals are being sent at regular intervals from station NKF of the Naval Research Laboratory at Bellevue, D. C., and are being received and oscillographed at the National Bureau of Standards field station near Kensington, Md. Records obtained since the first of the year show that on 4,045 kilocycles the sky wave arrives at the receiving station on the average 0.00143 second later than the ground wave, at 11.30 a. m. on normal days, while the retardation for the same frequency at 4 p. m. averages 0.00150 second. These retardations correspond to 225 and 235 km, respectively, as the apparent height of the ionized layer.

With the frequency of 8,650 kc, the average retardation is 0.00184 second at 11.30 a. m. and 0.00186 second at 4 p. m., corresponding to apparent heights of 287 and 290 km, respectively. The greater retardations for the higher frequencies may be attributed to dispersion. As with light waves, the index of refraction is thus shown to increase with frequency.

The retardations are shown to increase after sunset to values as high as 0.003 second for 4,045 kc. At sunrise they return abruptly to normal daytime values. Records obtained at 4 p. m. on March 13, 1930, during a magnetic storm, show retardations of 0.00162 second for 4,045 kc, and 0.00285 second for 8,650 kc, as compared with the normal values of 0.00150 and 0.00186 second, respectively.

It is planned to extend the study to other frequencies, in order to understand more completely the distribution of ionization, and to continue the observations over a considerable period of time so that seasonal variations may be studied.

TESTS OF AIRPLANE ANTENNAS

The bureau is conducting a research on receiving antennas for airplane use. As a result of preliminary work done in 1928 the vertical pole antenna was developed, and there is still every indication that it is the preferable type of antenna for reception on airplanes. Some difficulties have occurred in its use, however, which justify renewed study of the antenna problem directed both to removing these difficulties and to a more careful study of the possibilities of the several available types of antennas. The accumulation of ice on the vertical pole antenna encountered under certain weather conditions is a serious problem. In some cases this ice accumulation cuts down the signal markedly and also sets up vibrations which may be so severe as to break off the antenna or to endanger the airplane. A number of expedients are in view to eliminate these difficulties.

Some tests have been begun of the various possible types of fixed antennas. In addition to the vertical pole, these include a short longitudinal inclined antenna, the longitudinal horizontal antenna, transverse L antenna, transverse T antenna, a transverse horizontal dipole antenna, a wing-tipper T antenna, and combinations of these. These are being studied for their sensitivity, directional errors, and localizing effect (when over the beacon tower). The longitudinal inclined antenna, transverse T antenna, and wing-tipped T antenna give localizing effects which may be quite as useful as that obtained with the vertical pole antenna; these types, however, introduce errors in course indication which are due to the inclination of the antenna with respect to the course when the orientation of the airplane is shifted, and may be very large when within 5 or 10 miles of the beacon station. These preliminary results will be extended and more complete data obtained on the several types of antennas.

AIRPLANE DIRECTION FINDERS

One of the lines of aeronautic radio research work carried on by the bureau is the development of a direction finder for use aboard airplanes. Such a device is inherently more difficult for the pilot to operate than the radio range beacon aids. It, however, offers a means of navigation for the itinerant airplane or for any aircraft regardless of whether or not it follows one of the established airways. It thus supplements the department's radio range beacon system. A direction finder of the rotating-coil type is being developed, of maximum simplicity in use, usable either as a homing device or for bearing indications. A model has been constructed and is now under laboratory test, which is expected to fulfill these requirements. Flight tests on this direction finder will begin as soon as it is thoroughly tested in the laboratory.

This direction finder employs two small crossed loop antennas rotating as a unit. An antenna tuning system has been devised, permitting a unituning control and proper combinations of the two antenna currents without mechanical switching in the radio-frequency circuits. It operates on the comparison of two signals rather than on zero signal. Hence, it permits of specially advan-

tageous operation under conditions of atmospheric or external interference, and when used as a homing device gives a positive indication of the direction of deviation from the course. It also offers an adjustment whereby the course indications may be made as sharp as is desired.

Course indications may be either aural or visual. The aural indications may consist of the comparison of the intensities of two signals or these signals may be interlocked, giving the same course indications as in the aural radio range beacon system. Visual indication may be obtained by the use of a zero-center deflection instrument. With either type of course indication, bearings may be obtained from any transmitting station within the frequency range of the device. Means are also being worked out whereby a vibrating-reed indicator gives the indications, thereby taking advantage of the freedom from interference inherent in this type of indication.

The research work on this development is actively in progress and is expected to include flight tests of various types of direction finders.

THE SPECTRA OF LUTECIUM

A paper entitled "Regularities in the Spectra of Lutecium" has been prepared and will be published later in the Bureau of Standards Journal of Research. This is based on new observations of wave lengths and relative intensities of spectral lines characterizing lutecium atoms in successive stages of ionization. The lines were separated into three groups—the Lu_I spectrum of neutral atoms, the Lu_{II} spectrum of Lu^+ atoms, and the Lu_{III} spectrum of Lu^{++} atoms. Regularities were discovered in each of the three spectra, and practically all of the stronger lines have been explained as combinations of identified spectral terms. These spectral terms represent atomic energies and are associated with electron configurations in the atoms. The normal state of neutral Lu atoms is represented by a doublet D spectral term, that of Lu^+ atoms by a singlet S term and that of Lu^{++} by doublet S. This analysis shows that the spectra are produced by electrons in s, d, and p orbits only; the electrons in f orbits, assumed to be present in the rare earth elements, form a stable closed shell when 14 of this type are eached in lutecium atoms and, therefore, contribute nothing to the optical spectra. The spectra of lutecium are the first of any of the 14 rare earth elements to succumb to this method of analysis which gives information on atomic structure. In order to identify ytterbium lines which appeared as impurities in the lutecium spectra it has been necessary to photograph the former also.

SEPARATION AND DETERMINATION OF OSMIUM AND RUTHENIUM

During March, the bureau made a number of observations dealing with the separation and determination of osmium and ruthenium. It was found that osmium apparently can be quantitatively separated from all of the other platinum metals by distillation with nitric acid, and that it can also be quantitatively separated from ruthenium by distillation with sulphuric acid at a temperature approaching the boiling point of the acid. If a chlorate is added to the sulphuric-acid solution ruthenium can also be quantitatively distilled, thus offering a probable means of separating osmium and ruthenium together from iridium or other platinum metals which can then be followed by a separation of osmium from ruthenium by distillation with sulphuric acid alone. Further use of 6 N hydrochloric acid saturated with sulphur dioxide indicates that it is a satisfactory absorbing solution for both osmium and ruthenium. However, small losses of osmium were still found to occur in spite of the use of a newly designed set of receiving flasks. This loss may possibly occur during the evaporation of a solution, or during the precipitation of osmium dioxide by hydrolysis. The cause of this loss will have to be discovered and eliminated before the use of this method for the determination of osmium can be regarded as satisfactory.

ABERRATIONS OF ASTRONOMICAL OBJECTIVES

In connection with the construction of a 110 mm short focus telescope objective, it has been found that the test plates for determining the curvature of the surfaces by interference, when used in the usual manner, do not permit precise testing over the entire surface because of the deep curves. A new method of test has been devised, and an improvised instrument for applying it has been constructed. It has been found to work satisfactorily.

FILTERS FOR CHANGING THE COLOR TEMPERATURE OF INCANDESCENT SOURCES TO MEAN SUNLIGHT

The bureau has received a memorandum from the National Illumination Committee of Great Britain, Subcommittee on Colorimetry, prepared by J. Guild and entitled "Standard Illumi-

nant for Colorimetry." The following reference to the Davis-Gibson filters is taken from that memorandum.

> The extensive series of filters developed by Messrs. Davis and Gibson have a value which is not measurable by the merits of any one of the filters for any one specific purpose. These filters provide a basis for tackling innumerable problems connected with the color temperature scale, and with heterochromatic photometry, which is far in advance, as regards completeness and experimental accuracy, of anything hitherto available. There is nothing else comparable with them for such purposes; and research workers on photometry and colorimetry will necessarily use these filters for a variety of purposes, and will become familiar with the technique of their construction and use.

Mr. Guild, therefore, believes that "the committee ought to recommend a new standard employing filters from the Davis-Gibson series." He is also willing to use the value of 2,848° K., likewise recommended in the Davis-Gibson memorandum, as the color temperature of the source for use with the "white-light" filter.

ROOF EXPOSURE TESTS OF OUTSIDE WHITE PAINTS

During the past six years there have been exposed on the roof of the bureau's chemistry building a great variety of experimentally prepared outside white paints. Invariably these have been applied in either three coats on well-selected wood or in two coats on carefully cleaned metal panels. Repeatedly, straight white-lead paint has shown good durability. Likewise lead-zinc paints, provided the zinc-oxide content of the pigment does not exceed 30 per cent, have shown good durability. On wood panels, increasing the zinc-oxide content up to 50 per cent has resulted in rather bad cracking and scaling of the paint. On metal, the lead-zinc paints containing not over 30 per cent zinc oxide, are more durable (prevent rust) than straight white lead. Coming to the newer type of outside white paints on wood, the titanium-zinc paints show good durability, provided the zinc-oxide content does not exceed 30 per cent. These paints stay cleaner and whiter than the lead-zinc or white-lead paints. In May, 1927, a variety of experimental titanium-zinc paints were exposed. Some of these included in the pigment a mixture of titanox, zinc oxide, and white lead. After nearly three years of exposure, some of these paints are showing unusually good results. A mixture of about 45 per cent titanox, 35 per cent white lead, and 20 per cent zinc oxide is among the best. This paint is free from cracks, and has simply worn, by mild chalking, to a smooth, clean surface. Keeping the ratio of titanox and white lead about the same as in the paint just described, but increasing the zinc oxide to 30 per cent, resulted in a few cracks. Increasing the zinc-oxide content to 50 per cent resulted in bad cracking. Straight titanium oxide paints, straight calcium titanox paints, and straight barium titanox paints were not successful, due to excessive chalking. The liquid in these paints was 60 raw linseed oil, 20 heavy bodied linseed oil, and 20 turpentine and drier.

ENAMEL VERSUS ENAMEL AND VARNISH FOR AUTOMOBILE LICENSE TAGS

Over a year ago the bureau completed a test of coatings for automobile license tags in the accelerated cycle. Roof exposures of the same coatings were removed and examined last month. The accelerated test was a 37-day exposure of nine different manufacturers' products applied on license tags under practical operating conditions. Two sets of tags were coated with the background enamel (black) and the yellow numeral coating. One set then received a finishing coat of varnish, the other set did not receive this varnish. The varnish in every case was applied only over the enamel supplied by the same manufacturer. All the products (enamel and varnish) were for outdoor use, the varnishes being of the spar type. The results from exposing these two systems of finishing in the accelerated test were among the most instructive of any which the bureau has obtained. The test showed that on the varnished panels some varnishes in breaking down left the black-enamel undercoating clean, while others pulled off the undercoating down to bare metal, in much the same manner that glue will chip glass. What was more important, the accelerated test showed that instead of increasing the durability of the finish, the addition of the spar varnish over the black and yellow enamel coating decreased the durability in every one of the nine products. Unfortunately, the outdoor panels consist of only the one system of finishing, viz, the black and yellow enamel plus the clear coating of spar varnish on top. These have been exposed over one and one-half years and the same kinds of failure are being exhibited. On some tags the varnish has pulled off the undercoatings down to bare metal, resulting in excessive rusting. On others the varnish failed and has disappeared from the top of the coating, leaving the undercoating intact. It might be mentioned that as a result of the accelerated test just described, for the first time

the District of Columbia left off the clear varnish on the auto-license plates for 1930.

CAST IRON FOR ENAMELING PURPOSES

Since the close of research work on this investigation, a report of which has appeared, or will appear, in the Bureau of Standards Journal of Research, the Journal of the American Ceramic Society, Transactions of the American Foundrymen's Association, and Metals and Alloys, samples of iron which gave serious trouble in regular production have been sent in from three plants and have been studied with a view to determining the source of their blistering tendency. These samples, coming as they did directly from factories which were having trouble in actual production with the irons submitted, afforded an opportunity for the bureau to apply the findings of the investigation, and observe their efficacy. In the case of the first samples submitted, cross sections taken beneath the blistered areas and polished showed a spongy texture of the iron beneath. This condition is a mechanical cause of blistering, which was recognized and described in the report. The second sample submitted behaved in a rather peculiar manner when enameled. Chemical analysis showed it to contain only 1.2 per cent silicon, which is such a low silicon content as to place it outside the range of typical enameling irons. It had been melted in an electric furnace (susceptible to superheating) and appeared to have an approximately eutectic composition, with an excessive amount of very finely divided free carbon, which is believed to be readily oxidizable into the blister producing gas (mostly CO_2). There was, nevertheless, a narrow range of conditions under which this iron was enameled successfully. The recommendation made was to double, or more than double, the silicon content, and to eliminate the steel scrap being used in the charge, thus tending to avoid the eutectic composition. The third iron submitted was physically sound, and of more nearly typical chemical composition than the second. It was characterized as being the worst case of blistering iron which had come to the attention of the party submitting it. This iron behaved under enameling tests in practically the same manner as the iron which was studied in the investigation as representing a typical, severely blistering iron. When enameled under a variety of conditions it blistered strongly in most cases, but the preventives which were described in the report proved quite effective. These included deep sand blasting and annealing as production measures and machining as a laboratory test. The specimens from which the original surface had been thoroughly removed did not blister even when the ground coat was grossly overfired, a treatment which markedly accentuates any tendency to blistering.

The results obtained with these three irons thus fit in nicely with the findings of the investigation.

CHANGE IN VOLUME OF BURNED CLAY BODIES DURING USE

The preceding news items on this investigation in Technical News Bulletins Nos. 146 and 153 (June, 1929, and January, 1930) covered the work conducted at the Columbus Branch on experimental bodies and individual clays. The work was supplemented at Washington by an investigation of commercial semivitreous ware representing 16 brands. The expansion of this ware, resulting from the adsorption of moisture, was measured by the interferometer method. It has been shown that a ceramic body which has undergone "adsorption expansion" will undergo an equivalent shrinkage when heated because of the expulsion of adsorbed moisture. Tests on specimens taken from plates of 5 brands, and which had been stored in the laboratory for several months, showed that from zero to 0.06 per cent expansion had taken place. The plate which had apparently undergone no expansion had 2.0 per cent absorption while the absorption of the other 4 samples ranged from 9.4 to 12.5 per cent. Since the glaze on the plates was unbroken when the specimens were taken the results indicate that a slow expansion may take place in porous bodies in spite of a supposedly impervious coating of glaze. This would eventually result in crazing of the glaze, and once the glaze was broken the expansion of the body and resultant crazing could proceed with relative rapidity.

Specimens of each of the 16 brands of plates were also subjected to an autoclave treatment during which they were immersed in water under a pressure of 150 lbs./in.^{2} at approximately 182° C. for one hour. On removal from the cooled autoclave all of the specimens were badly crazed. Interferometer tests showed from 0.05 per cent expansion for the body of 2.0 per cent absorption to 0.14 per cent expansion for a body of 11.0 per cent absorption. As shown in the preceding news items, the composition may affect the relative expansion of a ceramic body as much, or more, than

the porosity. Therefore, it is not surprising that the porosity-expansion relation shown by results on these 16 bodies is only very general, although it does indicate that expansion may be expected to increase with increased porosity.

STUDY OF FIRE CLAYS

The results obtained in this bureau's study of 26 representative fire clays, reference to which was made in Technical News Bulletin No. 148 (August, 1929), will be published in full at an early date. Information included in the report relative to these clays covers:

1. Chemical analyses.
2. Tempering water and absorption of grog prepared from the clays.
3. Linear shrinkage and unfired strength.
4. Porosity of fired clay bodies.
5. Pyrometric cone equivalent values.
6. Linear thermal expansion.
7. Effect of temperature of firing on the mineralogical composition.
8. Moduli of elasticity and transverse strength of the fired clays.
9. Plastic flow.
10. Approximate location of the mines from which the clays were obtained, as well as a brief description of their geologic formation.

The chemical analyses of the clays show them to range from the aluminous type to the highly siliceous. The thermal expansions from 20° to 1,000° C. of the fire clays fired at 1,155° and 1,400° C. are given, and the clays classified into five groups according to their thermal expansion characteristics as determined by the free silica present either as quartz or in one or more of its allotropic modifications. The moduli of elasticity and transverse breaking strengths have been determined after receiving two different heat treatments and at several different temperatures.

The data obtained show that the thermal expansions of the fire clays determined after firing at 1,400° C. may be greater or less than after firing at 1,155° C., depending entirely on the composition of the clays. Thermal-expansion measurements and petrographic examinations given show the successive simultaneous development of cristobalite and mullite from the clays and finally the probable conversion of the cristobalite to a highly siliceous glass.

The moduli of elasticity and rupture of the clays are, with few exceptions, greater after firing at 1,400° C. than after firing at 1,155° C.

A comparison of the values for moduli of rupture and elasticity obtained at 550° C. with those obtained at atmospheric temperature shows, in general, that the percentage increase in moduli of elasticity and rupture is greater in highly siliceous clays than in aluminous clays. The plastic deflections of the clays, measured at 1,000° C. are much lower for those fired at 1,400° C. than those fired at 1,155° C., and are also lower in the siliceous type of clays than in the aluminous.

CEMENT REFERENCE LABORATORY

At the regional meeting of the American Society for Testing Materials, at Detroit, early in March, a report was made to Committee C–1 on the work of the Cement Reference Laboratory which has been set up by this association at the Bureau of Standards. The report was received with a great deal of interest, and the comments were very striking in showing the regard with which the public is receiving the work of the laboratory. There is no question but that it is doing an extremely good piece of work and one very highly appreciated.

COOPERATIVE TESTS OF COATINGS FOR PIPE LINES

On March 18 there was held in Tulsa, Okla., a conference called by the bureau to work out the details of an extensive test of protective coatings for pipe lines to be conducted jointly by the American Petroleum Institute, manufacturers of protective coatings, and the National Bureau of Standards.

Twenty types of protective coatings will be applied to working oil lines in 15 locations chosen to include soil characteristics ranging from severely destructve to mildly destructive. The types of coatings will vary from greases, emulsions, and enamels to bituminous materials reinforced with or covered by woven fabric and metals.

Provisions have been made for testing on short lengths of pipe laid alongside these working lines as many other coatings as the manufacturers care to submit. The only requirements for this test are that the manufacturer furnish an identifying description of his product, apply it under inspection, and pay a testing fee intended to take care of most of that part of the expense of the test which is proportional to the number of specimens tested.

It is hoped that the application of the coatings to working lines will be

started about June 1. The short lengths of coated pipe will be buried at the time the line is protected.

EXAMINATION OF PIPE SPECIMENS

The bureau has begun its biennial removal of soil-corrosion specimens. About 1,000 specimens of pipes made from pure iron, wrought iron, cast iron, Bessemer, open-hearth, and copper-bearing steel will be taken up from 70 soils. Most of these specimens have been in the ground approximately eight years. In addition to these, there are specimens of nonferrous metals and of metallic and bituminous protective coatings. The specimens will be cleaned, weighed, and put on exhibition. It is expected that they will be available for inspection about November 1.

CHART FOR DETERMINING THE HELIX ANGLES OF SCREW THREADS

A chart issued by the National Bureau of Standards during the past month shows graphically the relationships among diameters, leads, and helix angles of screw threads or other helical surfaces. This chart should prove of great value to mechanical engineers, since it furnishes a means for readily determining the helix angle at the major, pitch, or minor diameters or any of the standard pitches of the American National coarse, fine, hose coupling, pipe, and Acme threads as given in the 1928 Report of the National Screw Thread Commission. Usually, however, it is the helix angle corresponding to the pitch diameter which it is desirable to know.

The range of the chart includes diameters from 0.05 to 10 inches and 1 to 100 threads per inch. Diameters are represented by a vertical logarithmic scale, designated on each side of the chart, and leads (or pitches of single-thread screws) on a horizontal logarithmic scale along the top. For convenient use of the chart, vertical lines are drawn corresponding to the threads per inch of the various standard systems and these are designated along the bottom of the chart. The abscissa for a nonstandard pitch can be readily determined by interpolation on the lead scale and transferred to the diameter ordinate by means of a pair of dividers. The diagonal lines of the chart represent helix angles as designated.

Example.—To determine the helix angle at the pitch line of a ½''-20, 60° screw thread: The basic pitch diameter is 0.4675 inch. Reading opposite 0.468 on the diameter scale on the vertical line corresponding to 20 turns per inch, the diagonal line immediately below is 2° 0′ and interpolation gives the helix angle as 1° 57′.

There may be occasions, as in designing power transmission or conveying screws, when the helix angle would first be selected and a suitable corresponding combination of diameter and lead or pitch determined. Interesting comparisons of various standard screw-thread systems can also be made by plotting them on the chart.

Copies of this chart, known as Miscellaneous Publication No. 109 of the Bureau of Standards, may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents per copy.

TESTING EQUIPMENT FOR LARGE-CAPACITY SCALES

Equipment used by the various State weights and measures officials in testing high-capacity motor truck scales is described and illustrated in Miscellaneous Publication No. 104 of the bureau, which was released a short time ago. For example, one of the New York State officials uses 15,000 pounds of test weights, carried on a special truck.

In this publication, the bureau urges the various States, counties, and cities not having special scale-testing equipment to take immediate steps to secure it, in order that "greater service may be rendered to the owners of commercial scales and greater protection afforded to those who buy commodities over them." It is pointed out that the inspector who tests a modern 15 or 20 ton autotruck scale with only a light load of 1,000 or 2,000 pounds of test weights knows nothing about the accuracy of that scale in the most important part of its weighing range, which is above the weight of the empty truck and where the weights of commodity are actually determined. "There is a popular conception that a scale which will weigh a small load correctly will weigh any load within its capacity range with equal accuracy. This belief is entirely erroneous. A scale is, after all, nothing but a machine; it may have been improperly designed, made, or installed, or it may get out of condition through use, abuse, accident, or intent on the part of the owner or user. The superficial appearance of a good scale may not differ from that of a poor scale; initial and continued accuracy may only be demonstrated by adequate and regular tests." The recommendation for an "adequate" test-weight load for use by the inspector is 10,000 pounds.

Copies of this publication may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

EXAMINATION OF OLD NEWSPAPERS

Samples of old newspapers printed in this country and taken from the files of the New York Public Library were examined in reference to their state of preservation. The papers were first graded jointly by three persons with consideration of color and strength. Five different grades were observed; therefore, the best grade was designated No. 1 and the poorest grade No. 5, the others falling in order between these. The No. 1 papers were in excellent condition, having good color and strength. They showed little or no evidence of deterioration in any respect. The papers of No. 5 grade were badly deteriorated. They had a deep brown color and practically no strength, breaking with one fold.

After the papers were graded their fiber composition was determined and the appearance of their fibers noted.

Following are the fiber compositions of representative papers in the two extreme conditions and the dates of issue of the papers:

Grade to which assigned	Date of issue	Condition	Fiber composition (per cent)
1	1872	Well preserved.	Rag, 20; straw, 80.
1	1872	do	Esparto, 100.
1	1872	do	Esparto and straw, 90; ground wood, 10.
1	1872	do	Rag, 90; esparto, 10.
1	1872	do	Rag, 15; chemical wood, 15; straw, 70.
5	1876	Badly deteriorated.	Rag, 50; ground wood, 50.
5	1874	do	Rag, 65; straw, 10; ground wood, 25.
5	1877	do	Rag, 75; ground wood, 25.
5	1875	do	Rag, 25; ground wood, 60; straw, 15.
5	1875	do	Rag, 30; ground wood, 70.

NOTE.—Esparto is a grass used extensively abroad for paper making.

The complete results obtained will be published later in detail. They show the following interesting facts:

1. That while in the period covered by the samples, 1866–1880, a transition toward the use of ground-wood fiber occurred, the modern type of newsprint paper composed of ground wood and unbleached sulphite fiber, and which is known to be impermanent, had not yet come into existence.

2. That all of the papers of the period 1866–1873 are in excellent condition and are composed of fibers produced by chemical treatment from a wide variety of materials—rags, esparto grass, straw, and wood.

3. The papers issued during the period 1874–1880 showed more or less deterioration, and contained in most cases ground-wood fiber, which is a crude fiber, mixed variously with the chemical fibers mentioned in (2).

All of which is further evidence that the degree of purification of the paper fiber is an important factor in its permanence.

STANDARDS YEARBOOK, 1930

The Standards Yearbook for 1930, which was released last month, is more than a summary of interesting news. It covers broadly the developments in standardization during 1929 all over the world. In science standards are the basis of countless kinds of measurement. New methods of measurement may begin in the laboratory. They graduate into industry. A measuring device at first a novelty of the laboratory may later control the process of a giant industry—the pyrometer for example, or the photo-electric cell.

Industry has become a vast complex of measurements controlling the design, making, and use of its products. Broadly, standardization is the measured control of industrial evolution. Hence, it reaches out to touch every field of human activity. It includes simplification and "rationalization" as parts of a system designed to place the measurements of science in the controlling positions of industry.

The current Standards Yearbook begins with an article on the Government's interest in advancing standardization and simplification, a discussion prepared by the former assistant director in charge of the commercial standardization group of the National Bureau of Standards.

The yearbook points out that to promote uniformity of national standards, wherever this is feasible and desirable, and to exchange information on standardization work in the different countries, an International Standards Association has been organized. This is supported by the national standardizing bodies of the following 18 countries: Austria, Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Holland, Hungary, Italy, Japan, Norway,

Poland, Rumania, Russia, Sweden, Switzerland, and the United States. Thus, what is being done in the interests of national standardization in the United States by the American Standards Association is about to be undertaken on a world-wide basis, and should result in great benefits to all the countries concerned. In this connection, it is interesting to note that 21 nations now have national standardizing bodies, though they do not all support the International Association at the present time.

The yearbook records gratifying progress in the redetermination of the electrical units on a fundamental basis, thus tying them in with the mechanical and thermal units, since all refer back to standards of length, mass, and time. This work is being directed by the International Bureau on Weights and Measures, the research work itself being divided among the various national laboratories according to their facilities.

The publication of a revision of Rowland's preliminary table of solar spectrum wave lengths is of fundamental importance in astronomy and physics. This paper was issued by the Carnegie Institution of Washington during the year and is based upon a recommendation of the International Astronomical Union. Part of the work was performed by the spectroscopy section of the National Bureau of Standards.

An important event in connection with international standardization was the organization meeting, held in Mexico City September 16 to 22, of the Pan American Institute of Geography and History. This institute is designed to further the interests of geography throughout the Western Hemisphere, this science being considered to include geodesy. Already there is an arc of continuous triangulation from northwestern Canada, across the United States, to the southern border of Mexico. It is hoped, in the near future, to extend this arc southward into Central and South America. Undoubtedly the institute will have this in mind as one of the projects to advocate and push forward.

In his letter of transmittal to the Secretary of Commerce, Dr. George K. Burgess, Director of the Bureau of Standards, points out that, while, as in earlier issues of the Yearbook, special attention has been paid to the organization and procedure of the national standardizing agencies in the United States and abroad, the present volume likewise contains outlines of the activities and accomplishments of State, county, and municipal agencies, as well as those of technical societies and trade associations, "with special emphasis on their accomplishments during the year 1929, their program for future work, and the methods employed by each organization to encourage or facilitate the use of its standards and specifications."

Included among the special features of the Standards Yearbook, 1930, is an outline of important standardization activities in transportation, certain developments in the attempt to simplify the calendar (contributed by C. F. Marvin, Chief of the United States Weather Bureau), and a bibliography of recent publications on standardization, furnished through the courtesy of W. A. Slade, chief of the division of bibliography of the Library of Congress.

Copies of this publication (Miscellaneous Publication No. 106 of the Bureau of Standards) may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 75 cents each.

CONSTRUCTION ACTIVITY DURING JANUARY, 1930

Construction contracts valued at $323,975,200 were awarded in 37 Eastern States during January, 1930, according to reports of the F. W. Dodge Corporation, which was 21 per cent less than the total of awards, $409,967,900, in January, 1929, and lower than in 1928 and 1927 by 27 and 19 per cent, respectively. For the first time in nine years, however, the January total exceeded the value of contracts awarded during the preceding December.

Awards in the Middle Atlantic territory were 37 per cent greater this January than last. There was also an increase of 14 per cent in Texas, while awards in the New Orleans territory exceeded last January by 149 per cent. All other districts showed a falling off in activity in comparison with a year ago, ranging from 15 per cent in the Kansas City territory to 53 per cent in the Chicago territory.

Public and semipublic construction (excepting hospitals and institutions) were the only classes for which the value of contracts awarded was greater than in January, 1929. All these classes showed a combined increase of 58 per cent, while public works and utilities alone were valued at 69 per cent, more than a year ago. Of the other principal classes of construction, residential building was 52 per cent, commercial building 46 per cent, and industrial construction 39 per cent less than last year.

NEW AND REVISED PUBLICATIONS ISSUED DURING MARCH, 1930

Journal of Research [1]

Bureau of Standards Journal of Research, Vol. 4, No. 3, March, 1930 (RP Nos. 152 to 159, inclusive). Obtainable only by subscription. See footnote.

Research Papers [1]

(Reprints from Journal of Research)

RP129. Reliability of fusible tin boiler plugs in service; J. R. Freeman, jr., J. A. Scherrer, and S. J. Rosenberg. Price, 10 cents.

RP130. A simple control stopcock for gas analysis apparatus; Martin Shepherd. Price, 5 cents.

RP131. Throwing power in chromium plating; H. L. Farber and W. Blum. Price, 10 cents.

RP132. Influence of magnesia, ferric oxide, and soda upon the temperature of liquid formation in certain Portland cement mixtures; W. C. Hansen. Price, 10 cents.

RP133. Notes on the design of four-terminal resistance standards for alternating current; F. B. Silsbee. Price, 15 cents.

RP134. The effect of light on silver chloride in chemical analyses; G. E. F. Lundell and J. I. Hoffman. Price, 5 cents.

RP135. Method and apparatus used in testing piezo oscillators for broadcasting stations; E. L. Hall. Price, 10 cents.

RP136. Phase equilibria in the system SiO_2–ZnO; E. N. Bunting. Price, 5 cents.

RP137. Effect of small changes in temperature on the properties of bodies; M. D. Hersey. Price, 5 cents.

RP138. The neutralization of space charge by positive ions in caesium vapor; V. E. Whitman. Price, 5 cents.

RP139. Regularities in the arc spectrum of hafnium (Hf_1); W. F. Meggers and B. F. Scribner. Price, 5 cents.

RP140. Standards for testing magnetic permeameters; R L. Sanford. Price, 5 cents.

RP141. Ultra-violet reflecting power of aluminum and several other metals; W. W. Coblentz and R. Stair. Price, 5 cents.

RP142. The ring and ball method of test for softening point of bituminous materials, resins, and similar substances; P. H. Walker. Price, 5 cents.

RP143. Rayon as a paper-making material; M. B. Shaw and G. W. Bicking. Price, 5 cents.

RP144 A precision method of calibrating a tuning fork by comparison with a pendulum; C. Moon. Price, 5 cents.

RP145. The principles of measurement and of calculation in their application to the determination of Diaphantine quantities; E. W. Washburn. Price, 10 cents.

RP146. Durability tests of spar varnish; C. L. Came. Price, 5 cents.

RP147. A new dead-weight testing machine of 100,000 pounds capacity; L. B. Tuckerman, H. L. Whittemore, and S. N. Petrenko. Price, 5 cents.

RP148. Applying the visual double-modulation type radio range to the airways; H. Diamond. Price, 10 cents.

RP149. The absorption of sound at oblique angles of incidence; P. R. Heyl, V. L. Chrisler, and W. F. Snyder. Price, 5 cents

RP150 Sensitivity of a galvanometer as a function of its resistance; H. B. Brooks. Price, 5 cents.

RP151. Heat capacities in some aqueous solutions; F. D. Rossini. Price, 5 cents.

Circulars [1]

C380 (supersedes C300). Architectural acoustics. Price, 5 cents.

Commercial Standards [1]

CS7–29. Standard weight malleable iron or steel screwed unions. Price, 5 cents.

CS9–29. Builders' template hardware. Price, 10 cents.

Miscellaneous Publications [1]

M103. Weights and measures references (including an index to the reports of the national conference on

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75; other countries, $3.50. Commercial Standards Monthly, $1; other countries, $1.25.

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weights and measures from the first to the twenty-first, inclusive). Price, 10 cents.

M104. Testing equipment for large-capacity scales for the use of weights and measures officials. Price, 10 cents.

M105. Certification plan—significance and scope. Free on application to the bureau.

M106. Standards Yearbook, 1930. Price, 75 cents (foreign, 90 cents).

M109. Chart for determining the helix angles of screw threads. Price, 5 cents.

Commercial Standards Monthly[1]

Commercial Standards Monthly, Vol. 6, No. 9, March, 1930. Obtainable only by subscription. See footnote.

Technical News Bulletin[1]

TNB156. Technical News Bulletin, April, 1930. Obtainable only by subscription. See footnote.

OUTSIDE PUBLICATIONS[2]

In this list are included in so far as possible, all articles by members of the bureau's staff on scientific and technical subjects. Some of these articles are written in the author's unofficial capacity only and deal with subjects outside the field of the National Bureau of Standards. The article itself should always be consulted to determine whether or not it expresses the official opinion of the bureau.

Electrical codes. M. G. Lloyd; Public Utility Purchasing (Boffey Publishing Co., New York, N. Y.), Vol. II, No. 3, p. 96; March, 1930.

The bare grounded neutral and its problems. M. G. Lloyd; Proceedings, Fifth Annual Meeting, International Association of Electrical Inspectors (Chicago, Ill.), p. 48; October, 1929.

The accurate measurement of gas flows and the orifice meter. H. S. Bean; American Gas Journal (New York, N. Y.), Vol. 132, No. 3, p. 48; March, 1930.

Thermal expansion of copper-nickel-tin alloy. Peter Hidnert and W. T. Sweeney; Physical Review (Corning, N. Y.), Vol. 35, p. 667; March, 1930.

Summary (in German) with figures, of Bureau of Standards Research Paper No. 62 "thermal expansion of tantalum" by Peter Hidnert. Translated by Dr. Max Haas; Zeitschrift für Metallkunde (Berlin, Germany), Vol. 21, p. 395; November, 1929.

Testing the power of flame. S. H. Ingberg; United States Construction Magazine, (% United States Daily, Washington, D. C.), p. 5; March 15, 1930.

The gaseous explosive reaction at constant pressure—the reaction order and reaction rate. F. W. Stevens; National Advisory Committee for Aeronautics (Washington, D. C.), Technical Report No. 337; 1929.

Plan to reduce accidents among drivers proposed. H. C. Dickinson; United States Daily (Washington, D. C.), Vol. 5, No. 12, p. 1; March 17, 1930.

Use of isohydric indicators and superpure water for accurate measurement of hydrogen-ion concentration and salt errors. S. F. Acree and E. H. Fawcett; Journal of Industrial and Engineering Chemistry, Analytical Edition (Washington, D. C.), Vol. 2, p. 78; 1930.

Soundproof airplane cabins. V. L. Chrisler; The United States Aviation Magazine (care of United States Daily, Washington, D. C.), p. 6; March 8, 1930. This is a reprint from the Bureau of Standards Journal of Research; May, 1929.

Science strives for quiet. V. L. Chrisler and W. F. Snyder; United States Construction Magazine (care of United States Daily, Washington, D. C.), p. 6; March 15, 1930.

So that audiences may hear. P. R. Heyl; United States Construction Magazine (care of United States Daily, Washington, D. C.), p. 3; March 29, 1930.

An ice warning thermometer. H. B. Henrickson; Instruments (Pittsburgh, Pa.), Vol. 3, No. 3, p. 201; March, 1930.

Flight-test instruments. J. B. Peterson and E. W. Rounds; Society of Automotive Engineers' Journal (New York, N. Y.), Vol. XXVI, No. 3, p. 313; March, 1930.

The influence of chemical composition on the physical properties of glazes.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75; other countries, $3.50. Commercial Standards Monthly, $1; other countries, $1.25.

[2] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

F. P. Hall; Journal, American Ceramic Society (Columbus, Ohio), Vol. 13, No. 3, p. 182; March, 1930.

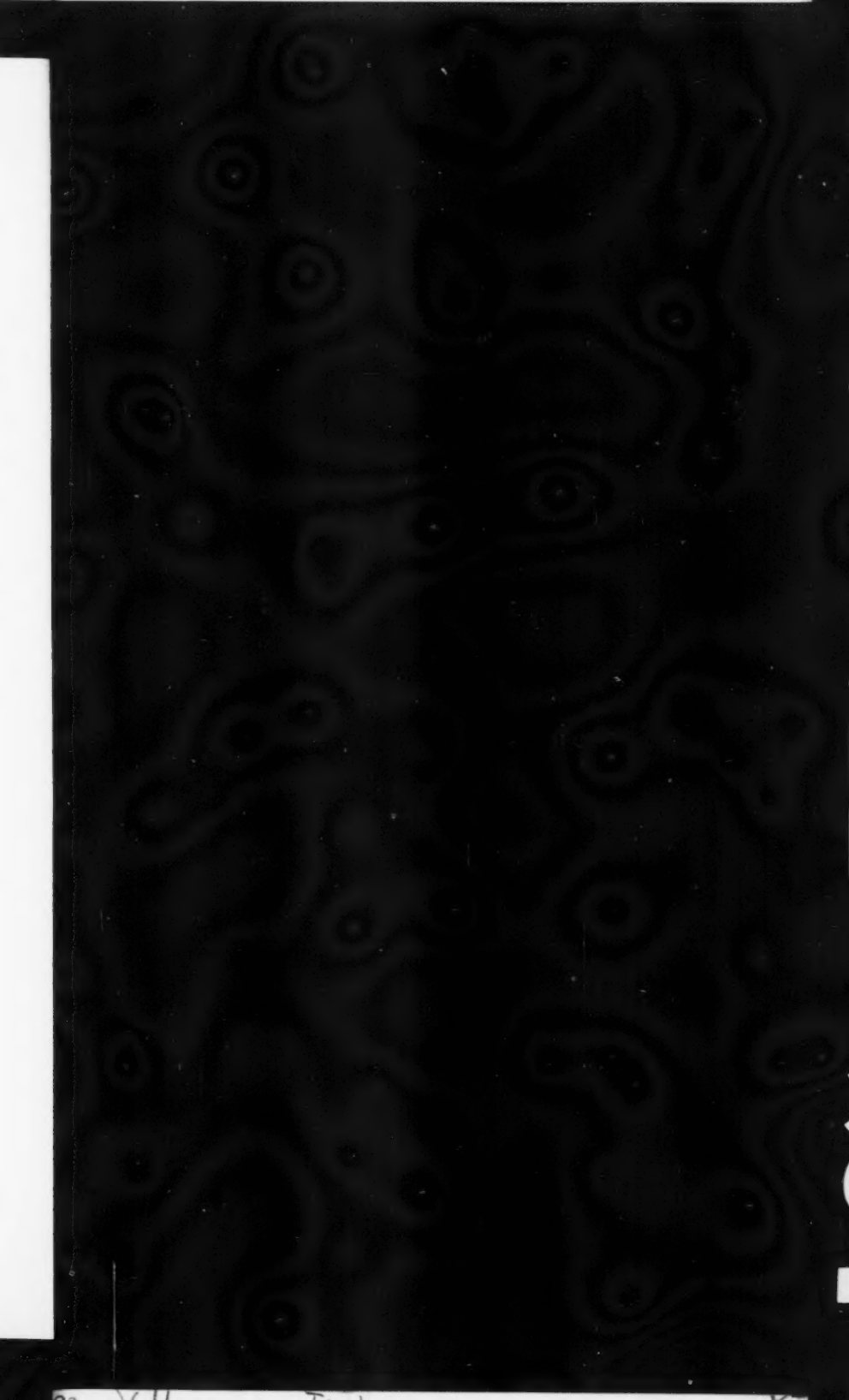
Simplification methods now recognized as integral part of successful business. E. W. Ely; United States Daily (Washington, D. C.), Vol. V, No. 8, p. 12; March 12, 1930.

Simplified practice in industry. R. L. Lockwood; National Sand and Gravel Bulletin (Washington, D. C.), Vol. 11, No. 3, p. 8; March, 1930.

New trends of home design. J. S. Taylor; United States Construction Magazine, (care of United States Daily, Washington, D. C.), p. 1; March 15, 1930.

Building code confusion—the way out. G. N. Thompson; National Real Estate Journal (Chicago, Ill.), Vol. 31, No. 4, p. 51; February 17, 1930.

Aid to building operations. D. H. Wheeler; United States Construction Magazine (care of United States Daily, Washington, D. C.), p. 1; March 29, 1930.

Two brilliant meteors observed in Washington. Hugh G. Boutell; Popular Astronomy (Northfield, Minn.), Vol. XXXVIII, No. 4, p. 247; April, 1930.

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